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I also certify that the attached copy of the request for grant of a Patent (Form 1/77) bears an amendment, effected by this office, following a request by the applicant and agreed to by the Comptroller-General.

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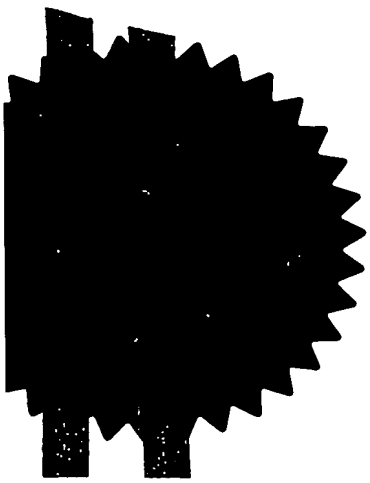

Signed A N Brewer

Dated 20 August 2004

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Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

1. Your reference — X440

2. Patent application number *(The Patent Office will fill in this part)* — 0316934.9 — 19 JUL 2003

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Xaar Technology Limited,
Science Park,
Cambridge,
CB4 0XR

7301872003

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation — UK

4. Title of the invention

Method of Manufacturing a Component for Droplet Deposition Apparatus

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Xaar Technology Limited,
Science Park,
Cambridge,
CB4 0XR

7301872003

MATHYS & SQUIRE
100 GRAYS INN ROAD
LONDON
WC1X 8AL

Patents ADP number *(if you know it)* 108100

	Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number			

	Number of earlier application	Date of filing *(day / month / year)*
7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application		

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

YES

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	---
Description	6
Claim *(s)*	2
Abstract	---
Drawing *(s)*	4

10. If you are also filing any of the following, state how many against each item.

Priority documents	---
Translations of priority documents	---
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	---
Request for preliminary examination and search *(Patents Form 9/77)*	Yes (1)
Request for substantive examination *(Patents Form 10/77)*	---
Any other documents *(please specify)*	Fee Sheet

11. I/We request the grant of a patent on the basis of this application.

Signature [signature] Date 18/7/05

12. Name and daytime telephone number of person to contact in the United Kingdom: Nick Roberts 01223 423 663

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Method of Manufacturing a Component for Droplet Deposition Apparatus

The present invention relates to a component for a droplet deposition apparatus and more particularly a nozzle plate for a droplet deposition apparatus.

A nozzle plate is typically attached to a body of a droplet deposition apparatus having a plurality of ink ejection chambers to provide each chamber with a respective droplet ejection nozzle. Due to the accuracy with which ejection nozzles must be formed in the nozzle plate, for example to ensure uniformity of the size and velocity of droplets ejected from the ejection chambers, laser ablation is commonly used to form the nozzles in the nozzle plate. Plastics material such as polyimide, polysulphone or other such laser-ablatable plastics material is commonly used to form the nozzle plate, and after the application of an ink-repellant layer to one face of the nozzle plate, each nozzle is formed by exposing the plate to a laser beam, such as an excimer laser beam, of appropriate diameter. The nozzle plate, complete with nozzles, is then bonded to the body of the apparatus with each nozzle aligned with a respective chamber formed in the body.

The use of plastics material for the nozzle plate tends to make the nozzle plate relatively weak, and thus prone to mechanical damage. Whilst stiffer materials, such as metallic or ceramics material, may be used for the nozzle plate, accurate nozzles are less readily formed in the nozzle plate.

It has been proposed in the prior art, e.g. from WO02/098666, that nozzle plates may be formed from a metal plate containing an aperture into which a polymer material is injected. A nozzle is subsequently formed through the polymeric material.

The metallic plate may be formed by an electroforming technique and, although not described, the photoresist that forms the aperture in the plate must be

removed before the aperture may be filled with the polymeric material.

It has now been recognised by the present inventors that when the nozzle plate component is built up using a technique such as electroforming the photoresist used to provide the apertures in the plate of WO 02/098666 may also be used to provide the polymeric material through which a nozzle may be formed and a droplet may be ejected.

In its embodiments the present invention seeks to provide an improved method for manufacturing a component for use in a droplet deposition apparatus.

In an aspect of the present invention there is provided a method of forming a nozzle plate component for a droplet deposition apparatus, said method comprising the steps: forming a body of a first material said body having a periphery, forming a plate of second material around said body such that the plate extends around at least a portion of said periphery of said body; and forming a nozzle extending through said body.

The plate is preferably formed by an electroforming technique.

The first material may be, for example, a positive or negative photoresist material. Especially preferred is a negative photoresist such as SU-8. The material may be masked and exposed to a form of radiation e.g. light to develop the un-masked portions.

The photoresist may be spun onto a substrate as a layer and subsequently processed to provide a plurality of distinct bodies. The substrate and where applied, a seed layer, may be used to form the plate material by electroforming or electroplating. The seed layer may be a sacrificial layer of copper or some other appropriate material.

The substrate may also be used, as a support during subsequent manufacturing steps e.g. attaching the actuator unit to the nozzle plate, building electrical tracks on the nozzle plate etc. The polymeric bodies continue to provide structural support to the nozzle plate.

The bodies may be provided as an array and thus form the plate such that the material of the plate surrounds at least a portion of the periphery of the each of the bodies.

The substrate may be provided with mould features which provide form to the bodies. In one embodiment the provided mould is tapered such that upon removal of the nozzle plate component from the substrate the nozzles are substantially formed.

In a particularly preferred embodiment nozzles are formed through the body by an ablative technique. Other techniques such as punching or etching may provide a nozzle of appropriate quality.

The nozzle plate component may be attached to a droplet deposition apparatus prior to or post forming nozzles through the bodies.

The robustness of the nozzle plate may be further increased by providing a further material which extends over a surface of the plate and preferably also over a surface of the body. The location of the further material, which may be electroformed, may be defined by a further, non permanent, resist defining an aperture through which droplets are ejected from the nozzles.

In one embodiment an insulating layer is provided on a surface of the nozzle plate component. Beneficially this allows for the possibility of electrical tracks being provided on said insulating layer. The tracks may be used to connect electrodes on the droplet deposition apparatus with a remote driver circuit.

In a further aspect there is provided a method of forming a nozzle plate for droplet deposition apparatus, the nozzle plate comprising a plate and a plurality of nozzles, each nozzle having an inlet, an outlet and a bore extending between the inlet and the outlet formed through polymeric material located within an aperture within the body, the method being characterised in that the plate is electroformed around the polymeric material.

The present invention will be described, by way of example only, with reference to the following drawings in which:

Figure 1 – Depicts a nozzle plate

Figures 2a) to 2e) show a method of manufacturing a nozzle plate according to the present invention.

Figure 3a) to 3c) describe a technique of forming a guard on a nozzle plate.

Figure 4a) to 4c) show a method of forming a nozzle plate attached to an electrical circuit.

Figure 1 depicts a nozzle plate according to WO 02/098666. The nozzle plate 1 is formed of a metallic plate 2 with an etched aperture. A polymeric material 4 is inserted into the aperture and subsequently a nozzle bore 6 is formed either by punching or ablation.

Figure 2a) to e) describes a method of forming the nozzle plate component according to the present invention. Where possible, the reference numerals used are the same as those used to describe the prior art. A copper seed layer 8 is deposited onto a substrate 10. A layer 12 of SU-8 photoresist is spun onto the seed layer.

The photoresist is masked, exposed and developed to leave a plurality of discrete bodies 4. The plate material 2 is subsequently electroplated or electroformed onto the copper seed layer thus forming a composite nozzle plate unit.

The nozzle plate unit may be released from the substrate by etching the copper seed layer to form a nozzle plate component. Nozzles may then be formed through the in-situ photoresist material either before the nozzle plate is attached to an actuator unit (ex-situ) or after the nozzle plate is attached (in-situ).

Overplating a portion of the resist provides a level of mechanical protection to the nozzles from paper impacts etc.

One of the additional benefits of the present technique is that the structural photo-imageable resists allow further structures to be built on the nozzle plate before ablating the nozzles and whilst it is still attached to the substrate.

In figure 3, a guard plate is formed on the nozzle plate thereby providing an protective layer. Firstly a second layer of photoresist 12 is deposited onto the nozzle plate component and this is patterned, exposed and developed to leave portions which extend over the structural resist.

A metal layer 14 is electroformed around the photoresist 12 and subsequently the photoresist is removed to leave apertures. Nozzles are then formed as described above.

It is also possible to form other features that may be located on either side of the nozzle plate. Figure 4 describes a technique of forming a nozzle plate having a conductive track attached thereto. The electroformed plate, whilst still attached to the substrate has spun thereon a further layer of an electrical insulation material 20 which will isolate the metal of the nozzle plate component from the

metallic tracks formed in the track component 22. The track component may be a separately formed sheet or may simply comprise tracks formed onto the insulating sheet 20.

Other features will be clear to a skilled person which would be obvious in the light of the present invention. It is the applicants intent to cover these features.

Each feature described herein may be incorporated into the claims either alone or in conjunction with one or more of other described features.

Claims

1. A method of forming a nozzle plate component for a droplet deposition apparatus, said method comprising the steps:
forming a body of a first material said body having a periphery,
forming a plate of second material around said body such that the plate extends around at least a portion of said periphery of said body; and
forming a nozzle extending through said body.

2. A method according to Claim 1, wherein said plate is electroformed.

3. A method according to Claim 1 or Claim 2, wherein said first material is formed as a layer on a substrate said layer being processed to form a plurality of bodies.

4. A method according to Claim 3, wherein said plurality of bodies are in an array.

5. A method according to any preceding claim, wherein said substrate is provided with mould features providing form to a respective body.

6. A method according to Claim 3, wherein said bodies are distinct from each other.

7. A method according to any preceding claim, wherein said nozzle are formed by ablating through said body.

8. A method according to any preceding claim, wherein said first material is a plastic material.

9. A method according to any preceding claim, wherein said first material is a photoresist.

10. A method according to Claim 9, wherein said photoresist is a negative photoresist.

11. A method according to Claim 3, wherein said processing step comprises the steps of masking said layer, exposing said layer to radiation and removing portions of said layer.

12. A method according to any preceding claim, wherein the said plate is attached to a droplet deposition apparatus before said nozzle is formed.

13. A method according to Claim 5, wherein said nozzle is formed by the act of removing said nozzle plate component from said substrate.

14. A method of forming a nozzle plate for droplet deposition apparatus, the nozzle plate comprising a plate and a plurality of nozzles, each nozzle having an inlet, an outlet and a bore extending between the inlet and the outlet formed through polymeric material located within an aperture within the body, the method being characterised in that the plate is electroformed around the polymeric material..

14. A method as substantially herein before described with reference to Figures 2 to 4.

15. Apparatus as substantially herein before described with reference to Figures 2 to 4.

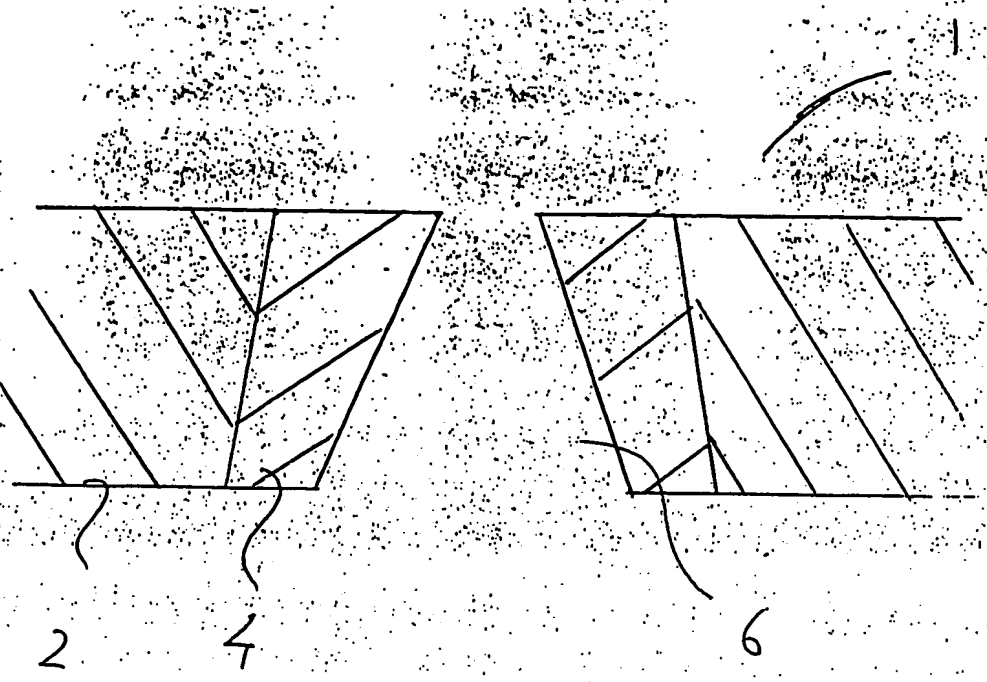
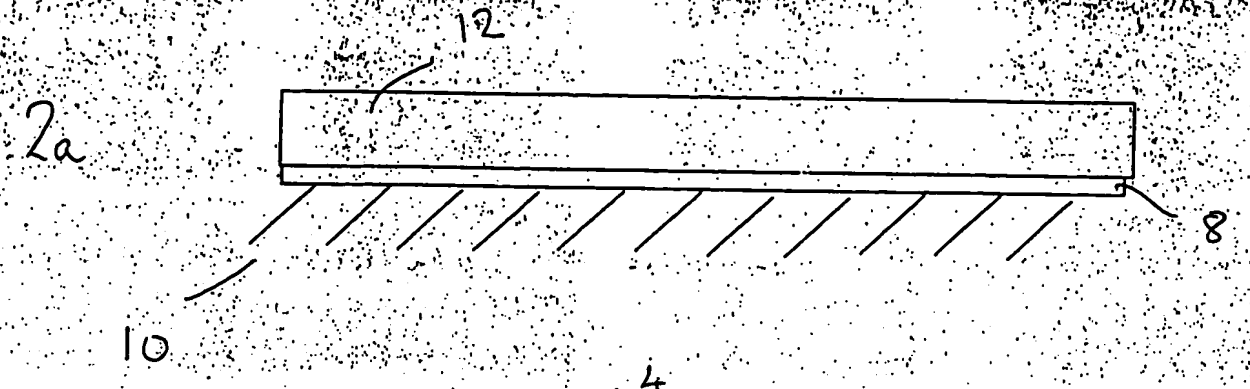


Fig. 1



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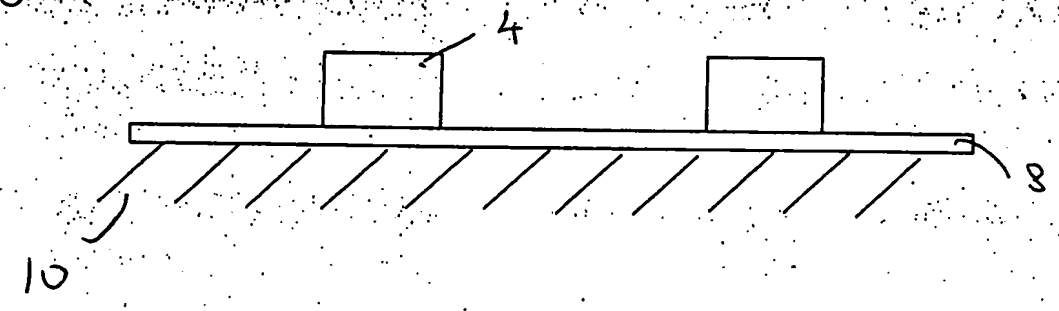

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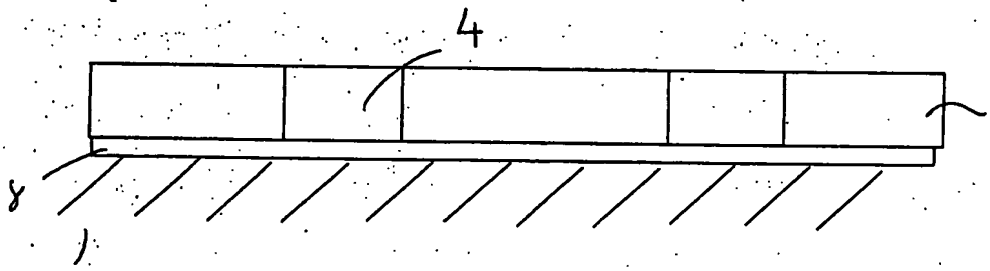

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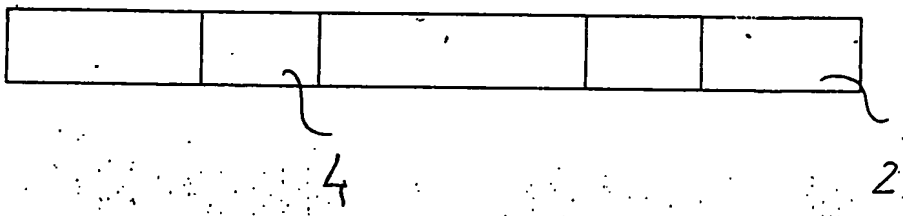

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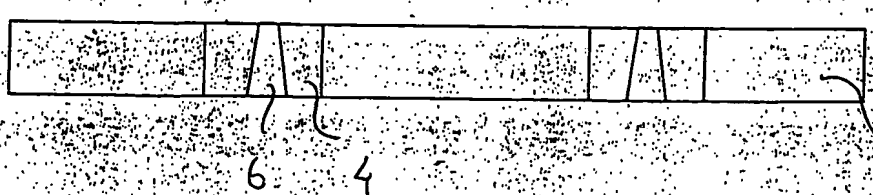

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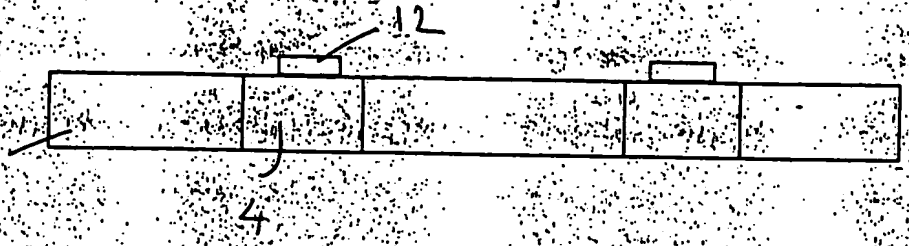

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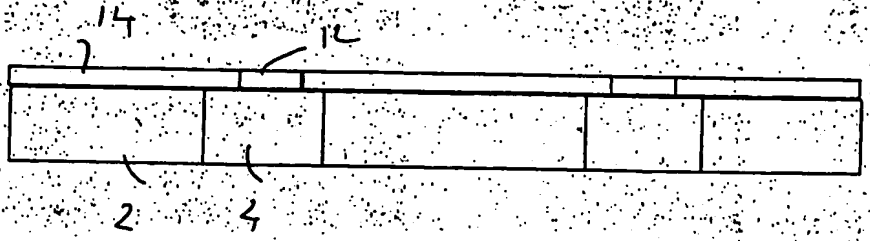

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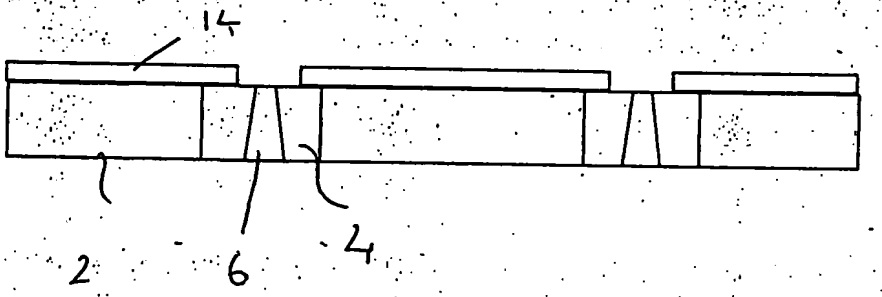


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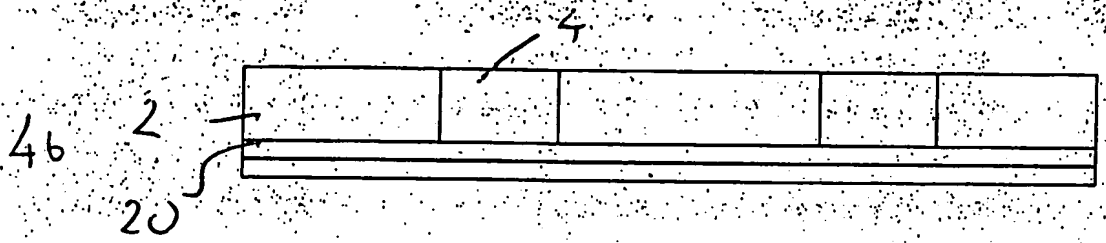
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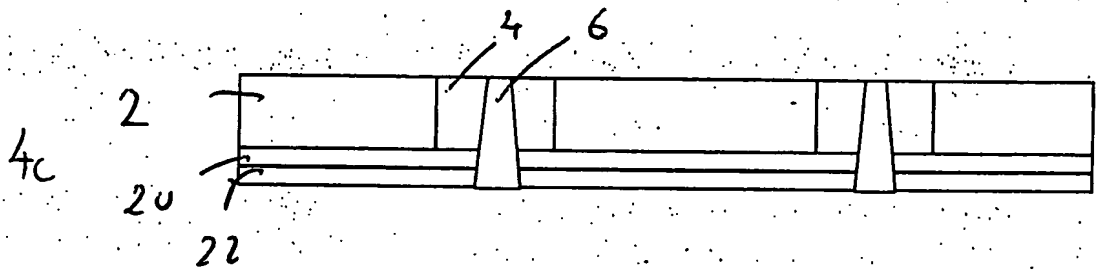
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